

Carbaryl Executive Summary for Draft Biological Evaluation

This Biological Evaluation (BE) assesses potential risks that registered uses of carbaryl (PC code 056801) may pose to an individual of a listed species or designated critical habitat. The federal action considered in this BE is the Registration Review for carbaryl, which encompasses the review of all the registered uses, and the approved product labels for all pesticide products containing carbaryl.

Listed species include those that are federally listed as endangered and threatened, as well as those that are proposed and candidates for listing and experimental populations. The methods employed in this BE follow the Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides (referred to as the “Revised Method”)¹. The Revised Method incorporates comments from the public, US Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS) and US Department of Agriculture (USDA).

As described in the Revised Method, EPA’s development of this BE includes two steps. The BE includes an evaluation of whether an individual of a listed species is reasonably expected to be exposed to a pesticide at a level that results in a discernable effect, and, if so, distinguishes effects that are likely to adversely affect an individual of a species from those that are not likely to adversely affect an individual. This process is also applied to the designated critical habitat of listed species (when available). In Step 1, for every listed species and designated critical habitat, EPA determines whether carbaryl will have No Effect (NE) or May Affect (MA) (separate determinations made for each species and critical habitat). For those species and critical habitats with MA determinations, in Step 2, EPA will determine if carbaryl is Not Likely to Adversely Affect (NLAA) or Likely to Adversely Affect (LAA) each individual species or critical habitat. Details on the method, models and tools used for making NE, NLAA and LAA determinations are provided in the Revised Method document.

1 General Information

Carbaryl is used on a wide variety of terrestrial food and feed crops, as well as uses in turf management, ornamental production, rangeland, and residential settings. Additionally, carbaryl is used to thin fruit in orchards to enhance fruit size and enhance repeat bloom. Carbaryl is also used to control mud and ghost shrimp in commercial shrimp ponds in Texas. There are currently five active technical registrants of carbaryl with 61 active product registrations (60 Section 3s and 1 Special Local Needs), which include formulated products (**APPENDIX 1-1**). There is one registered carbaryl product that is a Restricted Use Pesticide (RUP)² – meaning that it can only be applied by, or under the supervision of, a certified applicator. Carbaryl can be applied in liquid (*i.e.*, flowable concentrate, emulsifiable concentrate, wettable powder, water soluble powder), bait, granular, or dust forms. Aerial and ground application methods are allowed, as are pressure sprayers, dust applicators, spreaders and shank applicators, and baits (See **APPENDIX 1-2** for details).

Carbaryl enters the environment via direct application to use sites. It may move off-site via spray drift and runoff. Major routes of carbaryl transformation in the environment include alkaline hydrolysis, photolysis in water, and soil and aerobic aquatic metabolism. Abiotic hydrolysis under acidic conditions

¹ Available at: <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional>

² EPA Registration Number 9198-233 The Andersons GC Bicarb Insecticide + Fertilizer is a restricted use product containing carbaryl.

and anaerobic metabolism do not seem to play a significant role in the degradation and dissipation processes. Information on leaching and adsorption/desorption indicate that carbaryl is considered moderately mobile. The octanol-water partition coefficient ($\log K_{ow}$ 2.36) suggests that the chemical will have a low tendency to accumulate in aquatic and terrestrial organisms. Carbaryl has no degradates that are considered residues of toxicological concern.

Carbaryl is an N-methylcarbamate insecticide which act by inhibiting acetylcholinesterase, thereby reducing the degradation of the cholinergic neurotransmitter acetylcholine. As a result, intersynaptic concentrations of acetylcholine increase as the neurotransmitter accumulates leading to increased firing of the postsynaptic neurons which may lead to convulsions, paralysis, and death of an organism exposed to the chemical. Acetylcholinesterase inhibition is rapidly reversed in many taxa once exposure to an N-methylcarbamate insecticide has ended. Carbaryl is also used to thin blossoms in orchards; its activity in the abscission of flower buds may be related to its structural similarity to plant auxins, such as α -naphthalene acetic acid.

Carbaryl is practically nontoxic to birds and moderately toxic to mammals on an acute exposure basis. However, carbaryl demonstrated a variety of growth and reproductive effects at a range of exposure concentrations in birds and mammals as discussed in **Chapter 2**. Carbaryl is highly toxic to beneficial insects and bees. Carbaryl is moderately toxic to freshwater fish, and highly toxic to freshwater and estuarine/marine invertebrates on an acute exposure basis. Carbaryl has demonstrated adverse effects on growth to both vascular and non-vascular aquatic plants as well as terrestrial plants. There are reported ecological incidents involving carbaryl use for birds, mammals, terrestrial invertebrates, and terrestrial plants which are detailed in **Chapter 2**.

2 Exposure Methods

Exposure estimates are based primarily on fate and transport model results. Aquatic exposures (surface water and benthic sediment pore water) are quantitatively estimated for representative carbaryl uses in specific geographic regions within generic habitats (referred to as bins) using the Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM)³ in the Pesticides in Water Calculator (PWC). Aquatic exposure results for the bin(s) most appropriate for the species and/or critical habitat are discussed in **Chapter 3**. Also discussed in **Chapter 3** are available water monitoring data for carbaryl. For terrestrial exposures, existing models [*e.g.*, TerrPlant, AgDRIFT, AGDISP, earthworm fugacity model, Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS), Terrestrial Residue Exposure model (T-REX) and portions of the Terrestrial Investigation Model (TIM)] were combined and modified into a single tool that is referred to as the MAGTool (**Chapter 4**).

3 Overlap Analyses

Step 1 of the BE involves an analysis of the potential overlap of the action area and individual species ranges and critical habitat. The action area was derived in ArcGIS 10.7 by combining the data layers representative of carbaryl uses and then buffering them out to the off-site transport distance estimated using the AgDRIFT model (**APPENDIX 1-6**). The overlaps of action area and individual species' ranges or critical habitats were calculated. For 4 species and 5 critical habitats with no overlap (*i.e.*, species found outside of the action area), NE determinations were made. This analysis used spatial data of species'

³ The exposure models can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment>

ranges and habitats from the FWS and NMFS. In the contiguous United States, agricultural potential use sites are represented using the USDA Crop Data Layer (CDL) (**APPENDIX 1-5**). Other data sources are used to represent agricultural areas in states and US territories outside of the contiguous United States, for which the CDL is not available. All species or critical habitats with some overlap of the action area and their range or designated critical habitat, or with some overlap on species that the listed species depends on (**Chapter 4**) are assessed in the MAGTool to make LAA/NLAA determinations.

4 Effects Determinations

The MAGTool estimates the number of individuals of a listed species that are potentially affected, incorporating the degree of overlap of a species range with potential use sites and associated usage data for a chemical (and associated site transport areas) into the effects determinations. Using the toxicity endpoints for each taxa (**Chapter 2**), MAGTool utilizes probabilistic methods to assess how likely carbaryl will adversely affect an individual of a given species. Details on the individual effects determinations are found in **APPENDIX 4-1**. For each LAA determination, this assessment employs three categories (*i.e.*, strongest, moderate and weakest) to characterize the strength of the weight of evidence. To help determine the potential for risk, the MAGTool incorporates many of EPA's standard pesticide exposure models to estimate exposures to listed species and their prey, pollination, habitat, and dispersal (PPHD). If the model estimates are not considered representative of the exposure of the species (due to an inconsistency in the exposure model and assessed species' habitat), a qualitative analysis is conducted. In those cases, EPA makes either a LAA or a NLAA determination based on a qualitative weight of evidence.

For 1745 listed species, and 776 designated critical habitats, an NE, NLAA or, LAA determination is made. For each species and designated critical habitat, the effects determination is based on the methodology detailed in Chapter 1 and the Revised Method document⁴. MA determinations were made for 1741 species and 771 critical habitats. NE determinations were made for 4 species and 5 critical habitats. Specific species determinations are provided in **APPENDIX 4-1**. All species and critical habitats with a MA determination progressed to the Step 2 analysis where an NLAA or LAA determination is made. NLAA determinations were made for 199 species and 58 critical habitats. LAA determinations were made for 1542 species and 713 critical habitats.

For approximately 86 and 90% of all species and critical habitats, respectively, an LAA determination was made. Of those LAA determinations, 10% were considered to have strongest evidence of LAA, 85% were considered to have moderate evidence of LAA, and 5% were considered to have weakest evidence of LAA. In considering prominent risk drivers, Developed, Pasture, Forest Trees and Rangeland use data layers (UDLs) (corresponding to residential, pasture, forest tree, and rangeland uses), were often cited as the top use sites associated with impacts to a species. LAA determinations were made for species across all taxa. For certain species and critical habitats, there were uncertainties in the carbaryl effects determinations based on the resolution of spatial data, resolution of usage data, and the threshold for assessing impacts on PPHD (detailed in **Chapter 4**).

Tables 1 and 2 summarize the NE, NLAA and LAA determinations for species and critical habitats. **Table 3** summarizes the strength of evidence classifications for the LAA determinations.

Table 1. Summary of Species Effects Determinations for Carbaryl (Counts by Taxon).

⁴ Available at: <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional>

Taxon	Step 1 Effects Determinations		Step 2 Effects Determinations		Totals
	No Effect	May Affect	Not Likely to Adversely Affect	Likely to Adversely Affect	
Mammals	1	93	27	66	94
Birds	1	94	26	68	95
Amphibians	0	34	0	34	34
Reptiles	0	47	16	31	47
Fish	0	187	11	176	187
Plants	0	935	68	867	935
Aquatic Invertebrates	0	204	22	182	204
Terrestrial Invertebrates	2	149	29	118	149
Total	4	1741	199	1542	1745
Percent of total*	0%	97%	11%	86%	

* Represents % of all species on list including the 50 species for which effects determinations were not made (1795)

Table 2. Summary of Critical Habitat Effects Determinations for Carbaryl (Counts by Taxon).

Taxon	Step 1 Effects Determinations		Step 2 Effects Determinations		Totals
	No Effect	May Affect	Not Likely to Adversely Affect	Likely to Adversely Affect	
Mammals	0	32	7	25	32
Birds	0	28	3	25	28
Amphibians	0	24	0	24	24
Reptiles	2	14	4	10	16
Fish	0	104	2	102	104
Plants	2	450	26	425	453
Aquatic Invertebrates	0	70	5	65	70
Terrestrial Invertebrates	1	48	11	37	49
Total	5	771	58	713	776
Percent of total*	1%	97%	8%	90%	

* Represents % of all species on list including the 16 critical habitats for which effects determinations were not made (792)

Table 3. Classification of LAA Determinations by Strength of Evidence.

Strength of LAA call	Species range		Critical Habitat	
	Number	% of LAA determinations	Number	% of LAA determinations
Strongest evidence of LAA	154	10%	71	10%
Moderate evidence of LAA	1315	85%	609	85%
Weakest evidence of LAA	73	5%	33	5%